tion of Weyprecht and Payer, not worthless? Is it worth nothing that numerous Norwegian fishermen in sailing boats have been able to sail round Novaya Zemlya since 1869 and penetrate far into the Siberian ice sea, always finding it navigable and quite free from ice? Is it not worth remembering that at the time Payer and Weyprecht found the unwonted accumulation of ice by Novaya Zemlya, the western half of the great sea, *quite against the rule*, was free from ice, so that the Norwegian fishermen were able for the first time to reach the mystic Gillisland, which is King Charles Land? Under certain unfavourable conditions of wintering, the north side of Novaya Zemlya is, without doubt, as difficult and impossible for navigation as the north side of Spitzbergen, or Cape Horn, or the Cape of Good Hope, or the English Channel, or the mouth of the Weser.

The *Tegetthof* is a small steamer of 220 tons, and though her supply of coal was necessarily small, it proved ample, for steam could only be got up three times in the first three weeks of the voyage. And thus, as in all recent voyages, rowing boats proved themselves better fitted than steam launches for exploring work. In the summer of 1872, the journey from Cape Nassau could not be made in a straight course, but Count Wilczek's journey in the sailing vessel *Isbjörn* demonstrated that it was practicable by following a tortuous course.

The best and first account of the results of the Austrian expedition, in relation to their bearing on the present state of knowledge of arctic geography, and of the current setting into the icy sea from the south, is given by Dr. Joseph Chavanne, and is as follows :—

"The rising polar sun of 1874 lighted up and discovered a new land, now named Franz Joseph Land, and the expedition set off to explore it in sledges. They found the country to be a narrow, far-extending foreland, divided from Greenland by a wide arm of the sea now named Austria Sound. It is mountainous, approaching to a plateau, with steep conical mountains 5,000 feet high, covered with enormous glaciers. This newly discovered land stretches for more than 15° of longitude, and bounds the horizon with mountains as far as the eye can carry to the north and west. In 83° N. lat. they sighted Cape Vienna, the most northern point visible, and Cape Pesth, one degree further south, and finding the great glaciers impassable in this latitude, they returned to their icebound ship. Imperative necessity compelled them to abandon their vessel upon its icy platform, and they set out to return to Europe with four sledges. They travelled on for sixty-nine days, and then fell in with the Russian schooner *Nikolai*, who landed them at Vardoe, in the north of Norway. Austria Sound, and other fjords, were filled with icebergs. They met with no trace of human inhabitants, and remark that animal and plant life is scarce and small in the south."

Twenty-two years ago Dr. Petermann indicated on a map of the arctic regions the polar extension of the Gulf Stream. Though generally regarded at the time merely as the hypothesis of a German philosopher, the unwilling drifting of the *Tegetthof* in the ice has proved that the principal northern branch of the Gulf Stream washes the west and northern coast of Novaya Zemlya. Between the west coast of Novaya Zemlya and the east coast of Spitzbergen, enormous masses of ice press westward with the polar current flowing from New Siberia Island and the Siberian rivers, and penetrate wedge-like into the Gulf Stream. The temperature of Franz Joseph Land in the winter of 1872-73 was 40° Réaumur.

The remarkable correspondence between the coasts on the two sides of Greenland supports the conjecture that the polar land, if not subdivided into a number of islands by ramifying arms of the sea, is at least deeply indented by fjords, as is demonstrated by Hall's discovery of Petermann's Fjord on the west coast of Greenland and Franz Joseph's Fjord on the east.

*PHYSICS AT THE UNIVERSITY OF LONDON**

II.

TURNING then first of all to the Regulations for Matriculation in the University of London, we find that the knowledge of Physics that is required is specified under four heads: namely, *Mechanics; Hydrostatics, Hydraulics*, and *Pneumatics; Optics;* and *Heat*, which last, until quite recently, was included in the examination in Chemistry; and the whole is accompanied by a general qualifying note to the effect that "the questions in Natural Philosophy will be of a strictly elementary character." The particulars, which are given under each of the above general heads, read as if they might have been copied, as they stand, from the table of contents of an elementary treatise on Natural Philosophy published about a hundred years ago. I have examined them often and carefully, and have never found a tittle of internal evidence to show that they were drawn up within the present century; and yet we know that they are the work of a University, not yet forty years old, which owes its very existence to the demand for educational progress, and began its career—without indeed the wealth or the prestige of its older compeers — but also without the trammels of tradition and ecclesiasticism, which render it so difficult for them to advance with the times. It is not a sufficient defence of the antiquated character of these Regulations to say that the very nature of the examination to which they refer would make the introduction of new discoveries entirely out of place, and that, in point of fact, the fundamental doctrines relating to the subjects in question were as fully established a hundred years ago as they are now. This is so nearly true (except in the case of *Heat*), that it would not be worth while to dispute it; but my objection is not to the want of novelty in the subjects enumerated, but to the want of perception, which the manner of the enumeration indicates, of the possibility of progress or improvement in the ways of teaching long-known truths. Instead of giving prominence to general principles in such a way as to suggest to teachers the use of easy and comprehensive methods, these Regulations cut up the subjects to which they relate into a number of detached propositions, of greater or less generality, which teachers and students, who accept these Regulations as their guide, generally treat as independent units of knowledge each of which is to be put into a separate hole of the memory. It would be wearisome, but not difficult, to illustrate my meaning by particular examples; the substance of it is that this examination does not encourage good teaching of the elementary parts of Physics, but induces candidates to trust to memory almost to the total exclusion of any attempt at thinking. My opinions on this subject have not been formed *à priori*, but have been forced upon me by reading examination papers and by trying to teach in what I believed to be the best way. It is in general nearly hopeless to try to get students, who have the fear of the London Matriculation Examination before their eyes, to make any serious attempt to understand the principles of Mechanics; but they often show a lamentable willingness to learn statements of them by heart, and when they go up for examination they know a great deal and understand next to nothing. They know that in a lever of the first kind, whose weight is neglected, the power is to the weight as the weight's arm to the power's arm; that when a heavy body falls from rest, the spaces described in successive seconds are as the natural series of odd numbers; and they are ready at the shortest notice to write down the formula for calculating the specific gravity of a solid body heavier than water; but it is only in the rarest possible

* Introductory Lecture delivered at the opening of the Session of the Faculties of Arts and Laws and of Science, in University College, London, on Monday, Oct. 5, 1874, by G. Carey Foster, F.R.S., Professor of Physics. Continued from p. 508.

cases that they can be got to reproduce the reasoning by which these results are connected with general physical principles. The industry displayed in acquiring separate fragments of information about Physics is often extremely creditable; but it is impossible not to regret that the same method should be employed in learning what is called Science, as in learning the dates of accession of the Kings of England.

A still more curious instance of the antiquarian tendencies of the University of London is afforded by the Regulations for the Degrees in Science, which were instituted as recently as 1860. It might have been supposed that when the Senate had once determined to make so great an innovation in the traditional usages of English Universities as to grant Degrees in Science, they would have been impelled by the spirit of their own act to frame such regulations for the examinations as should be in full agreement with the present state of science. I recognise as fully as anyone the impropriety of introducing anything that can fairly be called a new discovery into examinations such as those for the London degree of Bachelor of Science, but between such a course and that adopted by the University there is a very broad *via media*. In order to obtain the degree of Bachelor of Science, a candidate requires, after Matriculation, to pass two further examinations, called respectively the First and Second B.Sc. Examination. At the former, a paper is set in what is called "Mechanical Philosophy," and another in "Natural Philosophy," the Mechanical Philosophy being a repetition of the subjects called Natural Philosophy at Matriculation, with a few additions, chiefly under the head of Optics, while the Natural Philosophy includes *Heat*, *Electricity*, and *Magnetism*. At the Second B.Sc. Examination there are two papers in "Mechanical and Natural Philosophy," which are explained by the Regulations to mean nearly the same parts of Statics, Dynamics, Hydrostatics, Pneumatics, and Geometrical Optics as those prescribed for the First B.Sc. Examination, but treated a little more fully, and with the addition of a very little Acoustics, a little Physical Optics, and a smattering of Astronomy. The details given in the Regulations under each of these general heads are open to the same general criticisms as those which I have already ventured to make upon the mode in which the requirements in Natural Philosophy are stated in the Regulations for Matriculation; in fact, those parts of the subject which are common to the three examinations are specified in very nearly the same words in each case, the difference being that a slightly more mathematical treatment of them is expected at the higher examinations. In each case there is the same failure to suggest general and comprehensive points of view, and the same enumeration of particular examples, as though they were of equal importance with the general principles which they illustrate. It is just as if, in an examination in Latin or Greek, instead of its being stated that candidates would be required to answer questions in grammar, lists of particular nouns and verbs were given with the announcement that candidates might be required to give the declensions or principal parts of any of these. But these Regulations are defective not only in form but in substance—not only in spirit but in matter. Without going into further details in order to justify this statement, I may mention, by way of illustration, that at the First B.Sc. Examination, under the head *Electricity*, there is no distinct reference to any of the quantitative laws of the science, and it is only by a laxity of interpretation quite unsuited to the subject that an obscure allusion to Ohm's Law can be discovered—the great law expressing the connection between the strength of an electric current and the nature of the circuit which it traverses; while, under *Heat*, no liberality of interpretation could detect the smallest trace of the Dynamical Theory of Heat. This last omission, however, ceases to be surprising when we find the steam-engine classed with the common pump and forcing-pump; the hydrostatic press, the barometer, and the air-pump, under *Hydrostatics*, *Hydraulics*, and *Pneumatics*. It might have been natural a hundred years ago to look for Newcomen's atmospheric engine among such company; but, even then, James Watt had nearly converted the old atmospheric engine into the modern steam-engine.

But there is no need to enter upon any minute investigation of the Regulations for these examinations, in order to be convinced that their effect upon the study of Physics must be unfavourable. The small amount of encouragement which they hold out to pursue this subject seriously is shown by the fact that a London Bachelor of Science is not required to have any more knowledge of heat, magnetism, or electricity than candidates for degrees in Medicine are required to show at the "Preliminary Scientific (M.B.) Examination," which, in the usual course of things, is taken one year after Matriculation; and also by the fact that the papers in Mechanical and Natural Philosophy set at the Second B.Sc. Examination are identical with those set in the same subjects at the Second B.A. Examination. I have no fault to find with one side of this last arrangement; I have already given reasons for considering that Physics ought to occupy an important place in general education, and, from this point of view, the physical subjects for the Second B.A. Examination are, on the whole, not injudiciously chosen; but it is certainly strange that a degree in Science should not imply any greater acquaintance with the fundamental principles of Mechanics than is demanded of candidates for the degree of Bachelor of Arts, the examination for which is in the main literary and classical. Another fact, which may be regarded as a sort of experimental proof that the examinations of the University of London do not promote such a study of the elements of Physics as can serve as the foundation for a more advanced study, is that for the last five years a special examination for Honours in Experimental Physics has been held in connection with the First B.Sc. and Preliminary Scientific (M.B.) Examinations, at which a Medal and a Scholarship of 40*l*. a year, tenable for two years, are offered to the most deserving candidate in case of his exhibiting sufficient absolute merit, but hitherto the scholarship and medal have never been awarded, and only once has a candidate obtained a First Class at this examination.

The other examinations of the University of London into which Physics enters to a greater or less extent, are, that for the degree of M.A. in Branch II., and those for the degree of D.Sc. in certain branches; but as these examinations come at a stage of a man's career at which it may be supposed that his methods of study are not greatly influenced by the regulations of examining bodies, and as, moreover, the Regulations of the University relative to these degrees do not go much into detail, there is no reason for dwelling upon them in connection with my present subject.

I do not propose to say much about that part of the examinations for which the Examiners, rather than the Senate, are directly responsible; but there are one or two considerations which, although sufficiently obvious, it may be worth while to point out. First of all, however, I shall venture, presumptuous as it may be thought, to make one remark on the choice of the persons best fitted to be examiners. It has more than once been claimed as a special merit of the University of London, that the examiners are not teachers, or at least that they have nothing to do with teaching the candidates whom they are called upon to examine. Fortunately, however, this is not the case. As a matter of fact, the great majority of the examiners are always teachers, and it may quite well happen, at least at some of the smaller examinations, that a majority of the candidates have been pupils of a single examiner. But I venture to think that, instead of this state of things being considered as a more or less

regrettable accident, it ought to be recognised as natural and desirable. If the real object of the examinations be to promote good teaching and sound learning, it is most important that, in setting the questions, the examiners should always keep in view their probable effect in giving direction to the studies of future candidates; and there can be no doubt that the men who are both most likely and most able to do this are those whose constant business it is to consider how the subjects in which they have to examine can be best brought before the minds of learners. Moreover, it is very difficult for examiners who are not also teachers, and teachers accustomed to pupils who are at about the same stage of advancement in their studies as the majority of the candidates, to know what amount of knowledge it is reasonable to expect. A man, however minute his own knowledge of his subject may be, generally soon forgets the exact steps by which he acquired it; and, unless he is in frequent contact with the minds of learners, he is no longer able to tell what, at any particular stage, it is creditable to know, and what it is disgraceful to be ignorant of. And again, though this perhaps is a less important consideration, the necessity which a teacher is under of periodically reviewing the whole round of his subject, is a great help towards a varied selection of questions.

With regard to the particular kind of questions which are most desirable in examinations like those of the University of London, I wish to say only a very few words. If the general considerations to which attention has been drawn in an earlier part of this lecture are of any value, it follows at once that examination questions in Physics ought to be selected with a view to testing the reasoning power and not the memory of candidates. If what are called *book-work* questions are admitted at all, they should be such as will bring out the power of reproducing trains of consecutive reasoning, and bringing facts to bear on the establishment of general conclusions, and not the power of simply recollecting individual facts. It may be said that such questions would be unfairly difficult. I can only say in reply that, if teaching were what it should be, I do not believe that this would be the case; but if it should be found to be so, I maintain that the inference is, not that any other style of examining in Physics should be adopted, but that the whole subject should be dropped. A late very distinguished member of the University once said that, in the case of candidates for Matriculation, all that could be fairly required at the examination in Physics was evidence of "correct acquisition." It would in my opinion be only a little more absurd to say that all that ought to be required at an examination in Geometry is evidence of the "correct acquisition" of Euclid. If Physics is not a subject upon which the intelligence should be exercised from the very beginning, it seems to me to be a waste of time to teach it at all.

The consideration of the kind of questions that are best fitted to be of use in promoting improved methods of teaching and learning, suggests a remark which bears upon the distinction that has often been pointed out between the subjects which it is desirable to teach and those which are most suitable for examinations. In the particular case of Physics, I am inclined to think that the very elementary parts of such branches as Heat and Electricity are not well adapted to form the subjects of examinations like those we are considering, where the examiners have no means of knowing the exact points of view from which the matters dealt with have been presented to the candidates. My reason for this opinion is the difficulty in these subjects of setting questions which require anything more on the part of candidates than mere exercise of the memory, and which at the same time are not unreasonably hard. As a practical inference, it appears to me that, if the amount of acquaintance with Heat, Electricity, and Magnetism represented by the London Regulations for the First B.Sc. Examination (supposing the regulations to be strictly interpreted) is all that can be fairly demanded at this stage of a student's progress, it is at least a question whether these subjects should not be deferred until a more advanced stage, when something more than descriptions of apparatus or the solution of arithmetical problems might be reasonably required.

If any of my audience have listened to this lecture with the consciousness that they will soon be going up to one or other of the examinations that I have been discussing, it may very possibly seem to them that I have been pleading throughout for making these examinations more difficult. To any to whom this seems to be the tendency of my remarks, I would venture to suggest one or two further considerations. In the first place, I fully admit that if examinations in Physics were to be such as I have advocated, that is, if they required candidates to *think*, while the teaching of Physics remained what too much of it now is—a mere loading of the *memory*—candidates would, no doubt, have a hard time of it; but the whole intention of what I have said is that examinations should be improved *in order* that teaching may be improved through their influence; and I believe that if teaching were what it should be, good examinations would be found to be no more difficult than bad ones. I may also observe that after all the precise degree of difficulty which an examination presents is not the most important consideration even for an intending candidate; what it really is important, not only for candidates but still more for those who regulate examinations, to consider is, what is the permanent educational value of the work which an examination requires, and not simply what is the amount of work needed. I have many a time in reading examination papers felt sincerely sorry for the writers when I saw how much labour they had evidently gone through in order to learn nothing—nothing that is of real use—and have thought how much the same amount of labour might have accomplished if it had only been better directed; and I beg leave to assure any who look upon examinations from the under side, that I have no wish whatever to add to the quantity of work that is already required of them; but what I do wish sincerely is, that whatever work they may be required to do in preparing for examinations may be such that they will be intellectually better and stronger for having done it. It cannot be too often repeated that degrees and university distinctions are of no more value in themselves than the Queen's head upon the coin: unless the metal is genuine, the stamp only makes it into a lying counterfeit. This has been urged upon students over and over again; what I shall be glad if this lecture tends in any degree to accomplish, is to press the same truth upon the attention of our University authorities. It is important for them to remember that a man is not really either better or worse for all the degrees that they can give him; and that their boast should be, not in the length of their lists of graduates, but in the extent to which they have promoted "a regular and liberal course of education."

NOTES

ONE of the first results of the Transit of Venus expedition with regard to the geological aspect and vegetation of a comparatively little known island, comes to us from Rodrigues, and is contained in a communication from Mr. J. B. Balfour to Dr. Hooker, under date, from the above island, of August 23, 1874. As a proof of the inhospitable, or rather the uncivilised nature of the island, it is stated that the party belonging to the expedition were warned in Mauritius before starting for Rodrigues that they must take everything from the former island that they would be likely to require as it would be impossible to get anything at Rodrigues, and even labour is most difficult to be obtained. After providing himself with various articles of abso-